Scientific Reports, 2015, vol.5

Pressure-induced electronic phase separation of magnetism and superconductivity in CrAs

Khasanov R., Guguchia Z., Eremin I., Luetkens H., Amato A., Biswas P., Rüegg C., Susner M., Sefat A., Zhigadlo N., Morenzoni E.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

 The recent discovery of pressure (p) induced superconductivity in the binary helimagnet CrAs has raised questions on how superconductivity emerges from the magnetic state and on the mechanism of the superconducting pairing. In the present work the suppression of magnetism and the occurrence of superconductivity in CrAs were studied by means of muon spin rotation. The magnetism remains bulk up to $p\simeq3.5$ kbar while its volume fraction gradually decreases with increasing pressure until it vanishes at $p\simeq7$ kbar. At 3.5 kbar superconductivity abruptly appears with its maximum $T_c\simeq1.2$ K which decreases upon increasing the pressure. In the intermediate pressure region ($3.5\lesssim p\lesssim7$ kbar) the superconducting and the magnetic volume fractions are spatially phase separated and compete for phase volume. Our results indicate that the less conductive magnetic phase provides additional carriers (doping) to the superconducting parts of the CrAs sample thus leading to an increase of the transition temperature (T_c) and of the superfluid density (ρ_s). A scaling of ρ_s with $T_c^{3.2}$ as well as the phase separation between magnetism and superconductivity point to a conventional mechanism of the Cooper-pairing in CrAs.

http://dx.doi.org/10.1038/srep13788